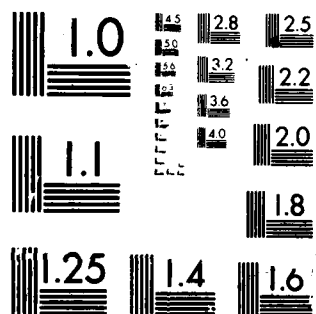


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USE OF MULTIVISCOSITY/SYNTHETIC ENGINE OIL IN ARMY COMBAT/TACTICAL VEHICLES

INTERIM REPORT
AFLRL NO. 118

by

J. D. Tosh
E. C. Owens

U. S. Army Fuels and Lubricants Research Laboratory
Southwest Research Institute
San Antonio, Texas

Under contract to

U. S. Army Mobility Equipment Research
and Development Command
Energy and Water Resources Laboratory
Fort Belvoir, Virginia

Contracts Nos. DAAG53-76-C-0003 and DAAK70-78-C-0001

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September 1979

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER AFLRL 118	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) USE OF MULTIVISCOSITY SYNTHETIC ENGINE OIL IN ARMY COMBAT/TACTICAL VEHICLES.		5. TYPE OF REPORT & PERIOD COVERED Interim Report January 1977-September 1979
6. PERFORMING ORG. REPORT NUMBER AFLRL No. 118		7. AUTHOR(s) J.D. Tosh and E.C. Owens
8. CONTRACT OR GRANT NUMBER(s) DAAG53-76-C-0003 DAAG70-78-C-0001		9. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 1L762733AH20EL; WU-B06
10. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Fuels and Lubricants Research Laboratory P.O. Box 28510 San Antonio, TX 78284		11. REPORT DATE September 1979
12. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Mobility Equipment Research & Development Command; Energy and Water Resources Lab, Ft. Belvoir, VA 22060		13. NUMBER OF PAGES 57
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) 1261		15. SECURITY CLASS. (of this report) Unclassified
15a. DECLASSIFICATION/DOWNGRADING SCHEDULE		
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Synthetic Engine Oil Synthetic Lubricant Arctic Engine Oil Combat/tactical Equipment Multiviscosity Fleet Test		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The military lube orders for combat and tactical equipment call for single-viscosity grade oils. The use of this type oil results in frequent oil changes caused by seasonal and climatic temperature changes. The use of a single "year-round" lubricant could eliminate the seasonal changes, possibly extend the oil drain interval, and provide a greater degree of combat readiness. MERADCOM began a pilot program to determine the feasibility of utilizing synthetic arctic engine oil in combat/tactical equipment outside		

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✓ 70. ABSTRACT

arctic regions. The program involved M60A1 tanks and M151A2 jeeps at selected CONUS military installations. After extensive field testing and evaluation, it was determined that use of the synthetic lubricant had no adverse effect on the equipment. However, environmental conditions and maintenance procedures greatly influenced the test results, causing high amounts of silicon to be injected. Thus, the normal oil drain intervals were not changed nor has a change in the vehicle engine failure/removal resulted.

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FOREWORD

This report was prepared by the U.S. Army Fuels and Lubricants Research Laboratory (AFLRL) located at Southwest Research Institute, San Antonio, Texas, under Contracts Nos. DAAG53-76-C-0003 and DAAK70-78-C-0001. The work was sponsored by U.S. Army Mobility Equipment Research and Development Command (USAMERADCOM), Fuels and Lubricants Division, Energy and Water Resources Laboratory, Ft. Belvoir, Virginia. The project monitor and Contracting Officer's representative was Mr. F.W. Schaekel, USAMERADCOM, DRDME-GL, Ft. Belvoir, Virginia. Acknowledgement is given to Messrs. J.A. Russell, S.J. Lestz, and R.B. Moon of AFLRL, and T.C. Bowen and M.E. LePera of MERADCOM for their participation, encouragement, and suggestions. Special acknowledgement is given to CW3 Roger Kleven of Fort Carson, Colorado and Mr. Joe Geraci of Fort Lewis, Washington as well as to Mr. W.W. Hardaway (AFLRL), who assisted in the data reduction/compilation, and Mr. J.W. Pryor (AFLRL) for technical editing assistance.

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LIST OF ACRONYMS AND ABBREVIATIONS

MERADCOM - Mobility Equipment Research and Development Command
PM M60 - Project Manager for M60 vehicles
OEA - Arctic Engine Oil
APG PD-1 - Aberdeen Proving Grounds Purchase Description No. 1
AFLRL - Army Fuels and Lubricants Research Laboratory
AOAP - Army Oil Analysis Program
MP - Military Police
R/R - Remove and repair
TCM - Teledyne Continental Motors
DIO - Director of Industrial Operations

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
I. INTRODUCTION.....	5
II. EQUIPMENT AND TEST PROCEDURES.....	7
A. M60 Fleet Test at Fort Carson, Colorado.....	8
B. M151A2 Fleet Test at Fort Carson, Colorado.....	11
C. M60 Fleet Test at Fort Lewis, Washington.....	11
III. CONCLUSION.....	16
IV. RECOMMENDATIONS.....	17
V. REFERENCES.....	18

APPENDICES

A - PILOT FLEET TEST PLAN.....	23
B - M151A2 TEST PLAN.....	29
C - FORT CARSON MONTHLY PROGRESS REPORTS.....	35

LIST OF TABLES

<u>Table</u>		<u>Page</u>
1	Description of Test Lubricants.....	7
2	Summary of Vehicle Operation.....	8
3	Summary of Vehicle Operational Data.....	12
4	Breakdown Analysis of Engine and Transmission Replacements.....	13
5	Vehicle Component Usage Comparison.....	14
6	Summary of M151A2 Vehicle Operational Data.....	15
7	Fort Lewis, WA Vehicle Operational Data.....	16

I. INTRODUCTION

Since the late 1960's, the Army has used synthetic engine oils for lubrication of equipment in the arctic regions.^{(1-6)*} Based on the successful arctic experience, continued efforts investigating the use of synthetic oils were incorporated into the Army's lubricant research and development programs.⁽⁷⁻¹⁰⁾

Presently, military lube orders for combat and tactical equipment call for single-viscosity grade oils. The use of these single-viscosity grade oils results in frequent oil changes caused by seasonal and climatic temperature changes. Since the use of a single "year-round" lubricant could eliminate the seasonal changes^(11,12), possibly extend the oil drain interval, and provide a greater degree of combat readiness, the U.S. Army Mobility Equipment Research and Development Command (MERADCOM) began a pilot program at Fort Carson, Colorado to determine the feasibility of utilizing synthetic arctic engine oil in combat/tactical equipment outside arctic regions.

Fort Carson was selected for this evaluation based on the results of an inspection visit by the Project Manager (PM), M60 Tank Development, in October 1975.⁽¹³⁾ During the PM M60 visit, the effect of altitude on engine cooling and the use of multiviscosity oils were discussed. Because of the altitude and locale, Fort Carson experiences extreme temperature fluctuations during the year. In early spring and autumn, the daily ambient temperature may change by 28°C. These temperature changes lead to difficult starting or lack of lubrication if a MIL-L-2104C⁽¹⁴⁾ grade 30 or grade 50 product is used in the vehicles. If a MIL-L-2104C grade 10 product is used to provide adequate startability at lower temperatures, the oil provides insufficient protection in the warmer ambient temperature during the middle of the day, leading to engine failure. This problem is particularly evident and critical in the air-cooled AVDS-1790 engines used in the M60 tanks.

The range of temperature variation would appear to justify use of a multiviscosity lubricant, but conventional multiviscosity products have been shown

* Superscript numbers in parentheses refer to the list of references at the end of this report.

to produce excessive deposits and insufficient wear protection in military diesel engines.⁽¹⁵⁾ However, a synthetic-based multiviscosity lubricant which has been used with good success is available in the military supply system under Military Specification MIL-L-46167(OEA).⁽¹⁶⁾ This 5W-20 grade engine lubricant was developed for use in the arctic and was previously identified as Aberdeen Proving Ground Purchase Description No. 1 (APG PD-1).⁽¹⁷⁾ This synthetic-based product has proved successful in high-output diesel engines under arctic conditions (-55° to +5°C), although the upper temperature extreme was lower than that encountered at Fort Carson.

In April 1976, based on the PM M60 inspection report, MERADCOM, Fort Belvoir, Virginia, recommended the following programs on multiviscosity oils for the AVDS-1790 engines.⁽¹⁸⁾

- A. "A 400-hour new AVDS-1790-2C laboratory engine dynamometer test operated under the mission profile cycle should be performed using one specific APG PD No. 1 product. This would confirm the suitability of a synthetic oil for use in the AVDS-1790-2C engine and indicate whether any performance problems would be anticipated.
- B. "Following satisfactory completion of the 400-hour dynamometer test*, a limited field test of the lubricant at Fort Carson should be performed with M60 tanks which accrue high use. The operation of these test tanks would be monitored closely to determine the effects of field environment, ambient temperatures, and driveability-type testing on the performance of this product."

In October 1976, discussions were held with the Fort Carson Director of Industrial Operations (DIO)⁽²¹⁾ on the fleet test possibilities; then in early January 1977, representatives of MERADCOM and the U.S. Army Fuels and Lubricants Research Laboratory (AFLRL) visited Fort Carson to complete details of the fleet evaluation.⁽²²⁾ In an attempt to determine if this lubricant would satisfy the Fort Carson requirements and help alleviate the operational problems, a limited fleet test was initiated in January 1977 using one of

* Note: The 400-hour dynamometer test was successfully completed in December 1977.^(19,20)

the MIL-L-46167-qualified products in M60A1 tanks. Due to the initial success of the pilot program which was conducted through May 1977, the program was expanded to include transmissions and final drives on the M60 tanks and four specially modified M151A2 jeeps.

In March 1979, the program was further expanded to include operational combat vehicles at Ft. Lewis, Washington.

II. EQUIPMENT AND TEST PROCEDURES

The initial pilot fleet evaluation included three M60A1 tanks. These vehicles are powered by the AVDS-1790-2A, a twelve-cylinder, air-cooled diesel engine. Two lubricants, described in Table 1, were used throughout the test. Two of the test vehicles (HQ-67 and HQ-68) were lubricated with MIL-L-46167 arctic oil and one vehicle (HQ-66) was operated as a control vehicle using a typical MIL-L-2104C OE/HDO-30 lubricant. The fuel used during the program was that available through the military supply system and was procured against VV-F-800A specifications.

TABLE 1. DESCRIPTION OF TEST LUBRICANTS

Description	ASTM Method No.	Oil A	Oil B
Specification		MIL-L-46167*	MIL-L-2104C
Grade		Arctic, OEA	OE/HDO-30
Properties			
Viscosity, cSt	D 445		
at 99°C(210°F)		6.14	11.90
at 38°C(100°F)		29.3	120.0
Viscosity Index	D 2270	185	96
TAN	D 664	0.2	2.0
TBN	D 2896	7.8	12.0
Flash Point, °F	D 92	460	440

*Formerly designated APG PD-1.

The three vehicles were operated by the 1/77 Armor, which also provided minor service and repair work. If major service of the engine or powerpack were required, the powerpack was removed and forwarded to the DIO Maintenance Division for rebuild. The condition of the engine oil was monitored by the Army Oil Analyses Program laboratories, initially at Tracy, California, then later at Fort Carson.

The pilot fleet test was conducted according to the test plan given in Appendix A. This test plan included procedures for initial oil installation and periodic oil sampling.

Later in the program, the M60 test fleet was expanded to include five additional M60s and four specially modified M151A2 trucks (jeeps). These M151A2 vehicles were equipped with specially manufactured low blowby pistons and piston rings. These vehicles were included in the test program to help evaluate the durability of the piston ring package. Three of these vehicles (vehicle Nos. HQ-9, P-7, and P-17) used the synthetic arctic engine oil and the fourth (P-73) used the OE/HDO-30 lubricant. The test plan for M151A2 vehicles is included in Appendix B.

A. M60 Fleet Test at Fort Carson, Colorado

On 14 January 1977, a pilot field evaluation was begun at Fort Carson, Colorado utilizing three M60 tanks to determine the feasibility of using synthetic arctic engine oil for crankcase lubrication of combat vehicles operating in nonarctic regions. The test was conducted 14 January 1977 through 20 April 1977.

The crankcases of two of the test vehicles (HQ-67 and HQ-68) were lubricated with APG PD-1 arctic oil and one vehicle (HQ-66) was operated as a control vehicle using MIL-L-2104C lubricant. During the test, the vehicles were subjected to normal mission/training operations. Mechanical problems were encountered with only one vehicle, HQ-66, which was corrected by replacement of a fuel injector and pump. Summaries of vehicle usage and fuel and oil consumptions are shown in Table 2.

TABLE 2. SUMMARY OF VEHICLE OPERATION

	Control HQ-66	5W-20 HQ-67	5W-20 HQ-68
Miles Traveled	286	301	478
Hours Operated	54	49	82
Oil Consumed, Quarts	28	20	20

During this test period, Fort Carson personnel noted the two vehicles operating on the arctic engine oil experienced significantly easier starting and appeared to develop increased power in comparison to the control vehicle and other M60 vehicles lubricated with conventional OE/HDO-30 oil. (See Reference 23 and Appendix C-1.) Also, analyses of used oil obtained from the vehicles indicated lubricant A (arctic oil) to be in satisfactory condition. Based on these results, it was concluded that the arctic engine oil would satisfactorily lubricate the AVDS-1790 engine and could possibly solve the oil-related problems previously reported for low-temperature operations of M60 vehicles at Fort Carson.

As a result of the successful completion of the three-month pilot test and the desire of MERADCOM and the Project Manager M60 Tank Development to evaluate synthetic engine oil to meet the Army's need for a multiseasonal oil which could also lubricate different components, i.e., transmissions^(24,25) and final drives, it was agreed that the test program at Fort Carson would be extended and expanded. During the period of negotiation, the original vehicles remained operational on their respective lubricants. However, little operational data were reported during this period due to changes in personnel, and the fact that the program extension lacked a firm commitment. On 10 August 1977, the program was expanded to include five additional vehicles. These vehicles were identified as vehicles Nos. A-31, A-32, A-33, A-34, and A-35. All five vehicles were converted to the arctic engine oil for a total of seven M60s operating on synthetic arctic engine oil and one M60 operating as a control vehicle on MIL-L-2104C lubricant.

During the period 15 September to 15 November 1977, the vehicles were involved in extensive training maneuvers. Tank commanders reported that vehicles operating on the arctic engine oil tended to operate at a higher engine temperature than experienced with vehicles using OE/HDO-30 oil. These temperatures were not considered excessive by the tank commanders, and it was noted the test vehicles also cooled faster than vehicles with grade 30 oil.

This potential overheating was investigated during August 1979 at Fort Carson.^(26,27) Two M60A1 non-RISE and two M60A1 RISE* engines were in-

* Reliability-Improved Selected Equipment.

strumented to measure the engine oil temperatures at the oil filter bypass valve and within the oil pan. For each engine configuration, one vehicle used a conventional MIL-L-2104C OE/HDO-50 lubricant, while the other vehicle of the pair was lubricated with the MIL-L-46167 test lubricant. The vehicles were then operated simultaneously over a test course which produced high engine temperatures. Figure 1 shows that the non-RISE configuration had an observed $5^{\circ} \pm 1^{\circ}\text{C}$ average increase in oil temperature with the MIL-L-46167 arctic oil; the maximum sump temperature measured was 149°C during a hot soak with the engine stopped. Figure 2 shows that the RISE engines had no significant differences in oil temperature with the maximum oil sump temperature achieved being 121°C . The two large drops in temperature experienced during the test are a result of the two scheduled maintenance stops at 10 and 20 miles into the test. As Figures 1 and 2 illustrate, the temperature difference between mineral and synthetic lubricants is small, taking into account the different starting temperatures of the vehicles. This slight difference would not be expected to result in any operational difficulties, since this represents only 3 percent of the peak temperatures encountered during vehicle operation.

Limited used-lubricant analyses⁽²⁸⁾ conducted during the period January 1977 through January 1978 showed significant silicon levels attributed to dust/dirt contamination from the Fort Carson environment; difficulties were experienced in maintaining the M60 vehicle air filtration system.

On 9 June 1978, the program was expanded to include the transmissions in all vehicles except the control vehicle (B-11, formerly HQ-66) and the final drives (left and right) in HQ-67.

Since the pilot program's initiation in January 1977, all engines, transmissions, and the one set of final drives have operated satisfactorily on the synthetic lubricant. There have been engine and transmission replacements during this program, but Fort Carson maintenance personnel have indicated that none of these failures has been attributed to the specific use of the synthetic lubricant. Table 3 shows a summary of vehicle miles, hours of operation, number of engine and transmission oil additions, and number of engine and transmission failures/replacements that have occurred throughout

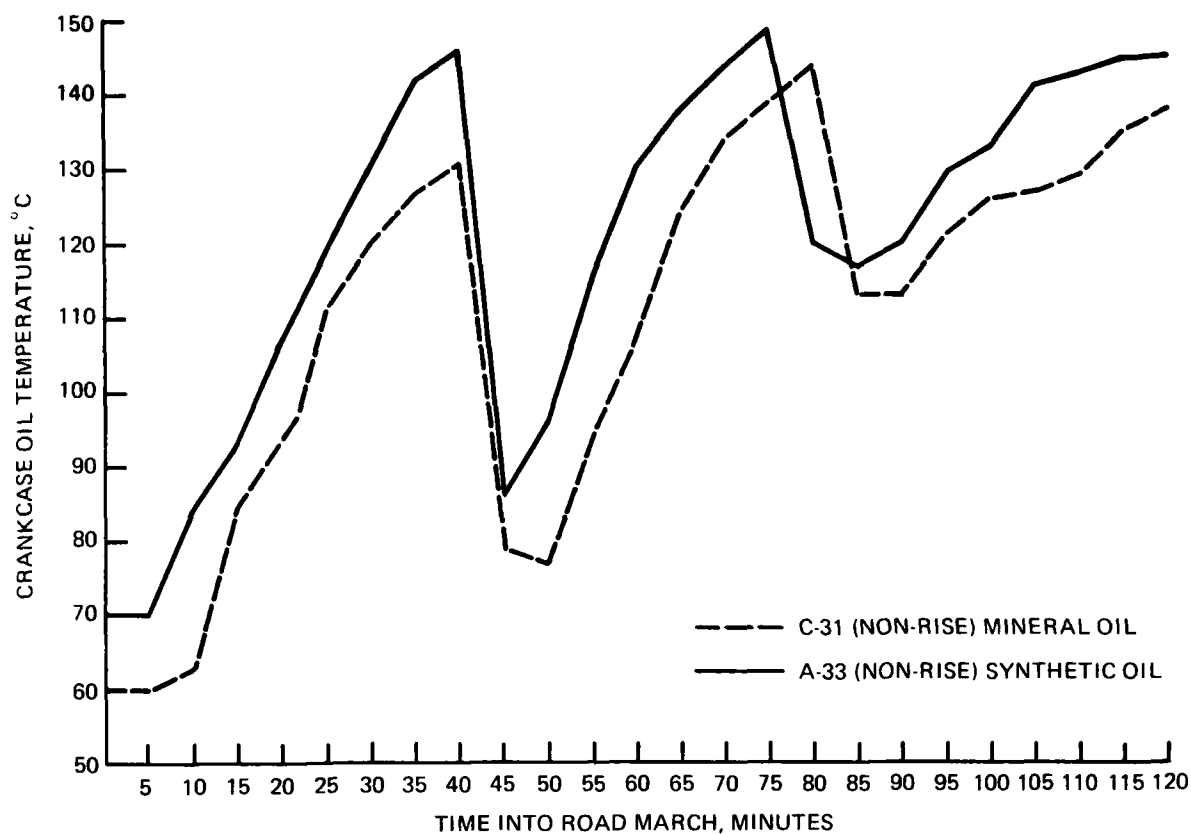


FIGURE 1. ENGINE OIL TEMPERATURE VS TEST TIME FOR NON-RISE ENGINES

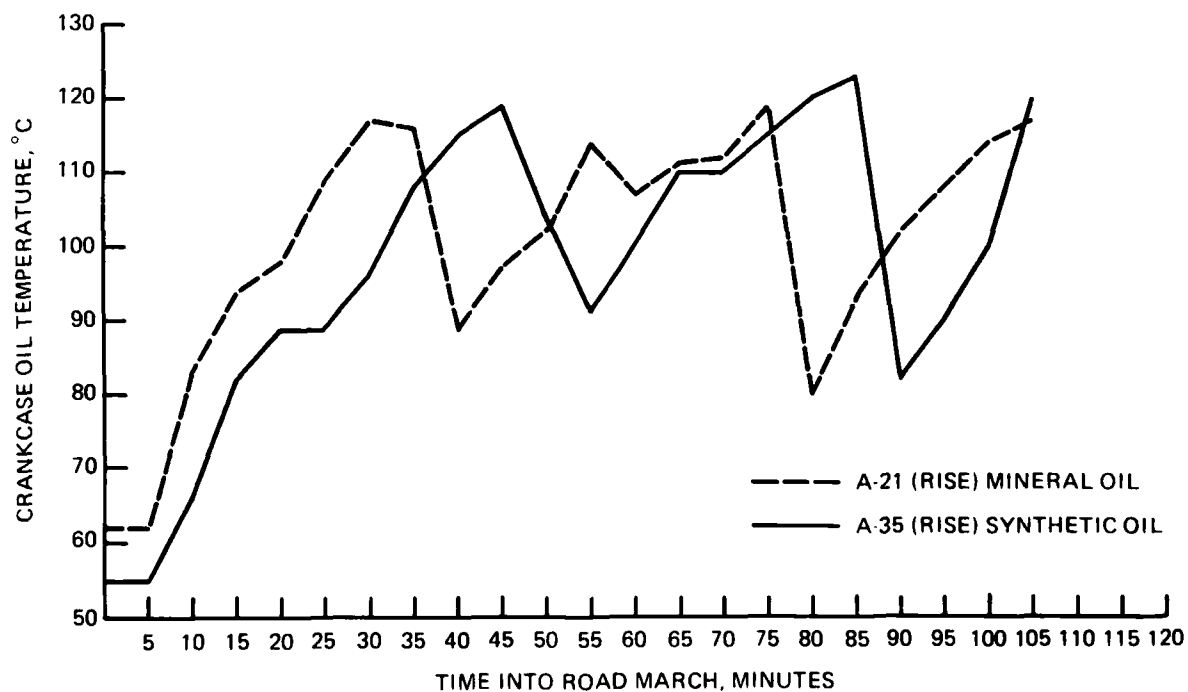


FIGURE 2. ENGINE OIL TEMPERATURE VS TEST TIME FOR RISE ENGINES

TABLE 3. SUMMARY OF VEHICLE OPERATIONAL DATA

<u>Vehicle No.</u>	<u>Total Hours</u>	<u>Total Miles</u>	<u>Total Fuel, Gal</u>	<u>Engine Makeup, Quarts</u>	<u>Trans Makeup, Quarts</u>	<u>Miles/Quarts</u>	<u>Number of Engine Replacements</u>	<u>Number of Engine Failures</u>
<u>TEST VEHICLES</u>								
HQ-67	154	1264	1502	117	97	10.8	0	0
HQ-68	254	1639	2249	51	0	32.1	1	0
A-31	210	1249	1617	43	90	29.0	1	0
A-32	263	1436	2168	27	111	53.2	1	0
A33	261	1505	1822	102	152	14.8	0	1
A34	94	599	459	37	68	16.2	1	1
A35	300	1866	1670	77	117	24.2	2	0
<u>M60A1 - CONTROL VEHICLE</u>								
B11	534	2519	3321	96	28	26.2	1	0

the test program. It should be noted in Table 3 that the control vehicle B-11 was formerly designated HQ-66 at the initiation of the program. Only the vehicle number changed--not the vehicle or components.

As also indicated in Table 3, there have been seven engine and two transmission replacements during this test program. However, in their failure analyses, Fort Carson maintenance personnel have not charged the lubricant as being responsible for any of the failures (see Appendix C, Fort Carson Monthly Progress Reports). Most of these components were removed at the direction of the oil analysis laboratory, usually for high silicon and metal content.

Those components experiencing mechanical difficulties would probably have experienced those difficulties regardless of the lubricant. The only failure that is possibly lubricant related was the failure that occurred in vehicle No. A-35 in which the connecting rod was thrown through the side of the crank-case (See Table 4).

TABLE 4. BREAKDOWN ANALYSIS OF ENGINE AND TRANSMISSION REPLACEMENTS

<u>Vehicle No.</u>	<u>No. of Engine Replacements/Date</u>	<u>Reason for Removal</u>
HQ-66(B-11) (Control)	1 (Sept 78)	AOAP directed
A-31 (test)	1 (between 21 Mar 78 and 20 May 78)	Low compression on three or more cylinders
A-35 (test)	1 (between 21 Mar 78 and 20 May 78)	Low compression on three or more cylinders
	2 (2 May 79)	Eng S/N A0808 threw connecting rod through side of crankcase- New Eng S/N A0283
HQ-68	1 (26 June 78)	One or two connecting rod bearings caps came loose and were thrown through bottom of crankcase
A-34 (test)	1 (Sept 78)	AOAP directed. New S/N 304
A-32	1 (April 79)	Leaking lower oil seal on engine cooling fan. New S/N A0005 (Rise)
	<u>No. of Transmission Failures/Date</u>	
A-34 (test)	1 (Sept 78)	Internal failure
	2 (May 79)	Cracked case

During cold weather operations, tank crew personnel reported vehicles utilizing synthetic arctic engine oil started much easier and appeared to have better performance than those vehicles operating on OE-30 grade lubricant. A comparison of component usage during cold weather operation was made between the seven M60s using synthetic lubricant and two platoons selected at random (each platoon has five M60s assigned) with the vehicles using OE-30 grade lubricant. Although a direct comparison cannot be made due to uncertainties in operations, Table 5 shows that component usage is considerably less in vehicles charged with synthetic lubricant. Savings in those components surveyed can amount to approximately 50 percent for vehicles using synthetic lubricant.

TABLE 5. VEHICLE COMPONENT USAGE COMPARISON

Component	Synthetic Oil Test Vehicles (7 Tanks)	Mineral Oil	
		1st Plt. "B" Co. (5 Tanks)	3rd Plt. "C" Co. (5 Tanks)
Generators, Main Engine	3	6	4
Battery, 6 TN	16	30	24
Starter, Engine	1	3	2

B. M151A2 Fleet Test at Fort Carson, Colorado

In addition to the M60 synthetic arctic engine oil test being conducted, a program involving four M151A2 jeeps is also being conducted at Fort Carson in a similar evaluation. All vehicles are equipped with specially machined low blowby pistons and piston rings. The first vehicle was placed on test in April 1977 with the 1/77 Armor. This vehicle is identified as administrative vehicle No. HQ-9 and was placed on test using the synthetic arctic engine oil. In March 1978, three additional M151A2s assigned to the 19th MP Battalion were also placed on test. Two of these vehicles, Nos. P-7 and P-17, utilize the synthetic arctic engine oil; P-73 became the "control" vehicle utilizing the OE/HDO-30 lubricant. Table 6 presents operational data on these four vehicles. The vehicles have operated very satisfactorily throughout the test program with little maintenance, and reports indicate the vehicles start easier during cold weather than those using regular 30-grade lubricant. However, due to rocker-arm cover design (only two hold-down bolts), leaks around the rocker-arm cover gasket are more prevalent.

C. M60 Fleet Test at Fort Lewis, Washington

In March 1979, six M60A1 tanks were placed on a 1-year synthetic engine oil evaluation. The vehicles were divided into two groups of three vehicles; the three test vehicles used MIL-L-46167 arctic engine synthetic oil and the three control vehicles used MIL-L-2104C engine oil. The three test vehicles were totally converted to the MIL-L-46167, i.e., engines, transmissions, and final drives.

TABLE 6. SUMMARY OF M151A2 VEHICLE OPERATIONAL DATA

Vehicle No.	Total Miles	Total Fuel, Gal.	Number Oil Changes	Makeup Oil, Quarts	Serial Number	Maintenance Performed
HQ-9	13,217	862	2	5	5029116	Two oil changes directed by AOAP Lab
P-7	3,347	317	2	0	5029165	<ol style="list-style-type: none"> 1. Rocker cover gasket replaced 2. Oil changed due to unit personnel erroneously adding one quart OE/HDO-30 3. Transmission repaired 4. Clutch repaired 5. Oil change directed by AOAP lab
P-17	4,068	351	2	1	5028906	<ol style="list-style-type: none"> 1. R/R engine assembly, pump assembly, engine oil, gasket set, engine oil pan gasket; 5 quarts test oil added 2. Rear crankshaft seal replaced, rod cover gasket replaced, rocker-arm cover gasket and oil pan gasket replaced 3. Headgasket replaced 4. Oil change directed by AOAP lab
Control P-73	2,179	215	2	0	5029136	<ol style="list-style-type: none"> 1. Parts kit flywheet installed; rocker-arm gasket, oil pan gasket, rear main seal replaced; engine tuned 2. Clutch repaired 3. Oil change directed by AOAP lab

Only one vehicle, No. B-13, experienced maintenance difficulties during this period. Both the engine and transmission were replaced. However, the cause of replacement of these components were not considered related to the use of synthetic lubricant. Table 7 presents operational data reported on those vehicles involved in the evaluation.

TABLE 7. FORT LEWIS, WA VEHICLE OPERATIONAL DATA

Vehicle No.	Hours of Operation	Miles	Fuel	Oil Added, Quarts			
				Engine	Transmission	LFD*	RFD*
B-13	5	58	150	0	0	0	0
B-22	56	367	815	2	8	1	1
B-34	57	196	650	15	8	0	0
<u>Control Vehicle</u>							
A-12	31	130	390	0	0	0	0
A-15	37	260	820	0	0	0	0
A-33	54	339	1050	4	6	0	0

* Left final drive and right final drive.

III. CONCLUSIONS

Throughout this evaluation, it has been evident that M60 vehicles can be adequately lubricated in multicomponents, i.e., engine, transmissions, and final drives, with MIL-L-46167 synthetic arctic engine oil. Few problems have been associated with the program, and most of these were not lubricant related.

Conclusions derived from the program include the following:

- Use of synthetic engine oil reduces M60 component replacements, i.e., batteries, generators, and starters, during winter operations.
- Use of synthetic engine oil in the engine, transmissions, and final drives of M60 tanks can eliminate seasonal oil changes and two additional products from supply inventory.
- Due to vehicles' operating in dusty environment and ingesting large amounts of silicon, oil drain intervals do not appear to be affected with use of synthetic products.

- Under certain engine-operating conditions, use of the synthetic oil may result in a slight increase in engine oil temperature. The measurements made to date are insufficient to confirm this possibility since vehicle-to-vehicle differences in operating temperature were not determined. However, the minor temperature change observed in this initial investigation is not expected to cause any operational difficulties.
- Based on the limited data presently available, it appears that use of the synthetic arctic engine oil has not caused a change in Fort Carson M60 vehicle engine failure/removal rate.

IV. RECOMMENDATIONS

Based on information generated in this evaluation, the following actions are recommended:

- Expand program to include all operational vehicles (particularly track vehicles) in an entire battalion.
- Until such a program expansion can be initiated, the limited testing at Ft. Carson and Ft. Lewis should be continued.
- Conduct a comprehensive cost-benefit analysis.
- Develop lower cost version of multiviscosity oils.

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5. Lestz, S.J. and Bowen, T.C., "Army Experience With Synthetic Engine Oils in Mixed Fleet Arctic Service," SAE Paper 750685, presented at National F&L Meeting, Houston, Texas, 2-5 June 1975.
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9. Stavinocha, L.L., "A Gas Chromatographic Method for Fingerprinting Synthetic Lubricants," Interim Report AFLRL No. 87, prepared at U.S. Army Fuels and Lubricants Research Laboratory, Southwest Research Institute, January 1977.
10. Tosh, J.D. and Russell, J.A., "Evaluation of Environmental and Economic Benefits Through Use of Synthetic Motor Oils," Interim Report AFLRL No. 91, AD A045277, prepared at U.S. Army Fuels and Lubricants Research Laboratory, Southwest Research Institute, September 1977.
11. Memorandum For Record, DRXFB-GL: Multiviscosity Engine Oil, 23 July 1976.
12. Owens, E.C., Lestz, S.J., Quillian, R.D., and McCormick, H.W., "Approaches to Extended Oil Drain Intervals in Army Tactical Equipment," presented at SAE International Fuels and Lubricants Meeting, Royal York, Toronto, Canada, SAE Paper 780954, November 1978.
13. DRCPM-M-60 TD letter dated 3 April 1976 to 4th Inf. Div. (Mech) at Fort Carson, Colorado.
14. U.S. Military Specification, MIL-L-2104C, Lubricating Oil, Internal Combustion Engine, Tactical Service, November 1970.
15. "Multigrade Oils for Diesel Application," Memorandum for Record, DRX-FB-GL, 16 March 1976.
16. U.S. Military Specification, MIL-L-46167, Lubricating Oil, Internal Combustion Engine, Arctic, Amendment 1, May 1978.

17. U.S. Army Aberdeen Proving Ground Purchase Description Number 1, Lubricating Oil, Combustion Engine, Sub-Zero, July 1969.
18. "Multiviscosity Oil for AVDS-1790-2A Engine," DRXFB-GL letter, 9 April 1976.
19. Trip Report 11 January 1978, AFLRL Inspection of AVDS-1790 Engine Operated on MIL-L-46167 Lubricant at Teledyne Continental Motors.
20. "Use of Multiviscosity Lubricants in M60/M48 Vehicle Family Powered by AVDS-1790-2A/2C Engines," Letter Report, DRCPM-M60-F to MERADCOM DRDME-GL, January 1978.
21. AFLRL Visitor Report, 27 October 1976: Fort Carson DIO visit to U.S. Army Fuels and Lubricants Research Laboratory.
22. Trip Report, 4-6 January 1977, MERADCOM and AFLRL representatives' visit to Fort Carson, Colorado.
23. Fort Carson Final Report on Synthetic Arctic Engine Oil, 12 April 1977.
24. P.D. Hopler and S.J. Lestz, "Application of Synthetic Engine Oils in Army Hydraulic and Power Transmission Fluid Systems," presented at 1975 SAE Off-Highway Vehicle Meeting, Milwaukee, Wisconsin, SAE Paper No. 750828, September 1975.
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26. Trip Report, 27 August 1979, AFLRL Measurement of M60A1 Oil Temperatures at Fort Carson, CO.

27. "Engine Oil Operating Temperatures--Mineral vs Synthetic," DF Report from Maintenance Tech, 1/77 Armor (WAN6AA), to Commander, 4th Inf. Div.(M), 19 October 1979.
28. "Used Oil Analyses-Fort Carson Pilot Fleet Test W/APG PD-1," Letter Report, AFLRL to DRDME-GL, 15 May 1978.

APPENDIX A
PILOT FLEET TEST PLAN

PILOT FIELD TEST PLAN

FOR FT. CARSON, CO

JANUARY - APRIL 1977

Purpose

To determine feasibility of using synthetic arctic engine oils in outside arctic operated combat/tactical vehicles.

Scope

Three M60 vehicles, powered by TCM AVDS 1790-2A engines, will be subjected to normal mission/training operations. Two vehicles will use APG PD-1 synthetic arctic engine oil provided by USAMERADCOM/AFLRL and one vehicle will provide a baseline (or reference case) operating using MIL-L-2104C OE/HDO-30 provided from Ft. Carson Supply.

Procedure

I. Pretest Vehicle and Engine Inspection/Preparation

A. Inspection

Review engines' operational/maintenance history for three selected vehicles. If a potential problem area is noted for a given engine, the engine will be replaced with another provided by DIO; see engine list attached.

B. Preparation

Before draining the original MIL-L-2104C, record oil pressure under fully warmed-up operating conditions for each engine. Drain the MIL-L-2104C single grade engine oil from the three test vehicle engines while the oil is warm. Retain a 12-oz. sample from each engine. Change engine oil filters and charge two engines with the APG PD-1 test oil and one engine with MIL-L-2104C OE/HDO-30. A flush of the previous oil is not required. Warm-up the engines and obtain a 9-oz.

sample from each engine using a suitable syringe and tubing to extract the oil through the dip-stick tube. Repeat the oil pressure measurement for all three engines in the same manner as described above. The oil samples must be identified with same information described in Section IIC.

II. Lubricant Testing

A. Duration

Subject the test vehicles to normal mission/training operation during period January through April 1977. No engine oil changes are to be made except as covered in Section III.

B. Information To Be Recorded

The following information should be maintained during course of the test in the form of a "Test Diary":

1. Oil Consumption: Date, hours, miles and quantity added.
2. Fuel Consumption: Date, hours, miles and quantity added.
3. Engine Maintenance: Date, action, reason; i.e., scheduled or unscheduled.
4. Changes in engine power/performance (i.e., good, better or worse).
5. Indications, if any, of oil leakage, and continuous observations of such leakage as long as it continues.

NOTE: For items 4 and 5, observations of both the operating crew and maintenance personnel should be made and recorded in the Test Diary. Comments relating to any of the above items or any unusual operations which may be of significance should also be recorded in the Test Diary.

C. Oil Sampling and Identification

After the initial oil sample is taken at start of test, a 9-oz. sample of warm oil should be taken from the engine every month or 25 hours of engine operation. Each sample must be identified as follows:

1. Vehicle USA No.
2. Engine S/N
3. Vehicle miles (total on vehicle).
4. Engine hours (total on vehicle).
5. Date of sample.

Samples should be mailed to:

U. S. Army Fuels and Lubricants Research Laboratory
% Southwest Research Institute, Attn: S. J. Lestz
P. O. Box 28510
San Antonio, Texas 78284

D. Conclusion of Test

On completion of test, a final oil sample of two gallons should be taken from each engine when the oil is drained. This sample should also be identified in the same manner as the other samples. All oil filters from each engine should be removed, packaged, and marked in same manner as the final oil drain sample.

III. Supplementary Information

A. Lower Oil Pressure

It is expected that due to its lower viscosity, the arctic engine lubricant will cause the engine-oil low pressure light/alarm to be activated during idle speeds. Operating personnel should be advised of this condition and that the engines will operate at lower oil pressure over the entire speed range.

B. Oil Changes

Since it is the intention of this field test to determine if the engine oil can help reduce routine maintenance and improve vehicle readiness, there will be no oil changes during the test. Exceptions to the above are as follows:

1. If the DIO and Commander decide that the one vehicle using the

OE/HDO-30 should be changed to the next higher viscosity grade due to expected temperature warming, then in accordance with the LO, the OE/HDO-30 will be changed. However, it would be highly desirable to use only OE/HDO-30 through the winter, and change the oil only if its condition indicates a change is needed.

2. If laboratory analyses of the OE/HDO-30 or the arctic engine oil indicate an oil change is merited, then notification for a change will be issued.

C. Engine Maintenance

Maintenance Division, DIO will provide maintenance support above organization level.

1/77 ARMORED BATTALION ENGINE HISTORY

HQ-66

Use MIL-L-2104C, OE/HDO-30

Mfg. in 1975
Original Engine
181 Hours
1433 Miles

HQ-67

Use APG PD-1

Mfg. in 1975
3rd Engine SN 1074
68 Hours
541 Miles

HQ-68

Use APG PD-1

Mfg. in 1975
4th Engine SN 8962
69 Hours
383 Miles

(Repaired - Maint. Div. - 11 March 1976
1 Cylinder & Piston Replaced
Other Cylinder > 300 psi
Dyno Run - 675 hp + 108 = 783 hp
issued.)

APPENDIX B

M-151A2 TEST PLAN

PILOT M-151 FIELD TEST PLAN

FOR FT. CARSON, CO

COMMENCING MARCH 1977

Purpose

To assess the feasibility of using multiviscosity synthetic arctic oil in conjunction with low-blowby piston rings developed for the M-151 vehicle, to allow extended drain intervals or no-oil-drain operation of the M-151 vehicle.

Scope

Four M-151 vehicles, equipped with modified pistons and low-blowby piston rings will be subjected to normal post operation. Two vehicles will use the APG PD-1 synthetic arctic engine oil as specified by USAMERADCOM and one vehicle will use MIL-L-2104C OE/HDO-30 from Ft. Carson supply, to provide a baseline or reference case.

Procedure

I. Pretest Vehicle and Engine Inspection/Preparation

A. Installation

The four engines fitted with special low-blowby piston rings and provided by the Army Fuels and Lubricants Research Laboratory(AFLRL) should be installed in the M-151 vehicles, with the standard engines removed and stored for later replacement. It is suggested that these engines be stored in the engine-shipping crates, which will be required at test completion.

B. Preparation

The cooling systems should be filled according to normal operating procedures for the climatic conditions. The three test engines should be charged with the APG PD-1 test oil. The vehicle to be used as a reference should be drained of oil while warm. An 8-oz. sample of this drain should be taken. Change the engine oil filter and charge the engine with MIL-L-2104C OE/HDO-30.

Warm up the engines and obtain a 3-oz. sample from each engine using a suitable syringe and tubing to extract the oil through the dip-stick tube. The oil samples must be identified with the same information described in Section IIC.

II. Lubricant Testing

A. Duration

Subject the test vehicles to normal mission/training operation. No engine oil changes are to be made except as covered in Section III.

B. Information To Be Recorded

The following information should be maintained during course of the test in the form of a "Test Diary":

1. Oil Consumption: Date, hours, miles and quantity added
2. Fuel Consumption: Date, hours, miles and quantity added
3. Engine Maintenance: Date, action, reason; i.e., scheduled or unscheduled.
4. Changes in engine power/performance (i.e., good, better or worse).
5. Indications, if any, of oil leakage, and continuous observations of such leakage as long as it continues.

NOTE: For items 4 and 5, observations of both the operating crew and maintenance personnel should be made and recorded in the Test Diary. Comments relating to any of the above items or any unusual operation which may be of significance should be recorded in the Test Diary.

C. Oil Sampling and Identification

After the initial oil sample is taken at start of test, a 3-oz. sample of warm oil should be taken from the engine every month or 3000 miles of operation.

Each sample must be identified as follows:

1. Vehicle USA No.
2. Engine S/N.
3. Vehicle miles (total on vehicle).
4. Date of Sample.

Samples should be mailed to:

U.S. Army Fuels and Lubricants Research Laboratory
% Southwest Research Institute
Attn: J. D. Tosh
6220 Culebra
San Antonio, Texas 78284

D. Conclusion of Test

On completion of test, a final oil sample of approximately one gallon should be taken from each engine when the oil is drained. This sample should also be identified in the same manner as the other samples. All oil filters from each engine should be removed, packaged, and marked in same manner as the final oil drain sample. The four test engines should be drained of all fluids and removed from the vehicles. The engines should then be crated and shipped to AFLRL for post-test disassembly and inspection.

III. Supplementary Information

A. Lower Oil Pressure

It is expected that due to its lower viscosity, the arctic engine lubricant may cause the engine-oil low pressure light/alarm to be activated during idle speeds. Operating personnel should be advised of this condition and that the engines will operate at lower oil pressure over the entire speed range.

B. Oil Changes

Since it is the intention of this field test to determine if the engine oil can help reduce routine maintenance and improve vehicle readiness, there will be no oil changes during the test. Exceptions to the above are as follows:

1. If the DIO and Commander decide that the one vehicle using the OE/HDO-30 should be changed to the next higher viscosity grade due to expected temperature warming, then in accordance with the LO, the OE/HDO-30 will be changed. However, it would be highly desirable to use only OE/HDO-30 through the test and change the oil only if its condition, as determined by laboratory analyses indicates a change is needed.

2. If laboratory analyses of the OE/HDO-30 or the arctic engine oil indicate an oil change is merited, then notification for a change will be issued.

C. Engine Maintenance

Maintenance Division, DIO will provide maintenance support above organization level.

APPENDIX C
FORT CARSON MONTHLY PROGRESS REPORTS

DEPARTMENT OF THE ARMY
HEADQUARTERS, 1ST BATTALION 77th ARMOR
"BLACKHAWKS"
Fort Carson, Colorado 80913

WAN6AA

12 April 1977

SUBJECT: Synthetic Artic Engine Oil Program Report

THRU: Commander
2d Bde, 4th Inf Div (M)
Ft Carson, CO 80913

TO: Maintenance Division, DIO
ATTN: Mr. Chester Johnson
Bldg 8000
Ft Carson, CO 80913

1. Background: Three M60A1 tanks were selected from HHC, 1/77th Armor for the synthetic artic engine oil evaluation. The admin (bumper) numbers assigned are HQ 66, 67 and 68. All three vehicles were operated under normal conditions and oil pressure readings recorded (at inclosure 1) for the tanks selected to switch to the synthetic oil). The three engines were then removed from the hulls after oil samples were taken, drained and new oil filters installed. Regular OE-30 was installed in HQ-66 and synthetic oil installed in HQ-67 and 68. The three engines were then ground hopped to check for visable oil leaks. The only leaks detected were stopped by tightening hose clamps on oil return lines. The engines were then installed and the tanks operated for ten miles after which new oil samples were taken. Oil samples taken prior to and after the oil and filter changes were then sent to Fuels and Lubrications Lab in San Antonio, Texas.

2. Comments:

a. Maintenance: The only malfunction of the three evaluated tanks to date has been the transmission failure in HQ-66.

b. Crew:

(1) Tanks start easier using the synthetic oil

WAN6AA

12 April 1977

SUBJECT: Synthetic Artic Engine Oil Program Report

(2) Vehicles using synthetic oil seem to be more responsive to accelerator position and develops more power.

3. A final evaluation will be published in May. If further assistance is required contact CW3 McIntosh at Fort Carson ext 3189.

FOR THE COMMANDER:

1 Incl
as

CHARLES M. HUFF
CPT, Armor
Adjutant

Oil pressure reading of M60A1 engines using
synthetic arctic engine oil and idling at 750 RPM

HQ-67

	<u>COLD</u>	<u>HOT</u>
OLD OIL	50 PSI	65-70 PSI
NEW OIL	45 PSI	60-65 PSI

HQ-67

OIL OIL	50 PSI	70-75 PSI
NEW OIL	40 PSI	55-60 PSI

DEPARTMENT OF THE ARMY
HEADQUARTERS, 1ST BATTALION 77TH ARMED
"BLACKHAWKS"
Fort Carson, Colorado 80913

WLN6AA

10 May 1977

SUBJECT: Synthetic Arctic Engine Oil (Final Report)

THRU: Commander
2nd Bde, 4th Inf Div (M)
Ft Carson, CO 80913

TO: Maintenance Division, DIO
ATTN: Mr. Chester Johnson
Bldg. 8000
Ft Carson, CO 80913

1. Tests were concluded on 20 April 1977. Oil samples and fillers assemblies were sent as directed in the basic letter. Specifics of the test follow:

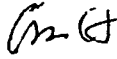
HQ-66 (OE 30)	HQ-66 (OE 30)	HQ-67 (Synthetic)	HQ-68 (Synthetic)
Engine Oil Consumption	28 qts	20 qts	20 qts
Fuel Consumption	350 gal	330 gal	513 gal
Miles Traveled	286	301	478
Hours of Opn	54	49	82

2. Engine maintenance, only HQ 66 the M60 using OE 30 experienced mechanical difficulty. It required new injector and a pump during the evaluation.

3. Changes in engine power/performance operators of HQ 67 and 68, both using synthetic oil report, the engines started easier and seemed to have more power.

4. Oil leakage, no new oil leaks were discovered during the evaluation.

FOR THE COMMANDER:


CHARLES M. HUFF
CPT, ARMED
Adjutant

DEPARTMENT OF THE ARMY
HEADQUARTERS, 1ST BATTALION, 77TH ARMOR
"BLACKHAWKS"
Fort Carson, Colorado 80913

MAN6AA

10 August 1977

SUBJECT: Pilot Fleet Test Involving Use of Arctic Oil at Fort Carson

THRU: Commander
2nd Brigade
4th Infantry Division (Mech)
Fort Carson, Colorado 80913

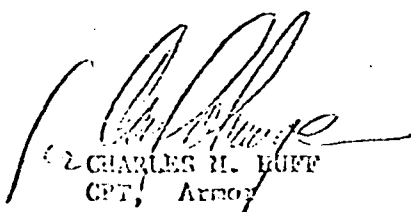
TO: Maintenance Division, DIO
ATTN: Mr. Chester Johnson
Building #8000
Fort Carson, Colorado 80913

1. Effective this date, five additional tanks of the 1st Battalion, 77th Armor are included in the Arctic Oil Test Program.
2. Tanks selected for the program are from Company A and specifics follow:

<u>ADMIN #</u>	<u>SERIAL #</u>	<u>ENGINE SERIAL #</u>	<u>ENGINE MILEAGE</u>
A-31	5747	8860	169
A-32	6990	21027	1979
A-33	3632	6546	1657
A-34	5924	2508	668
A-35	2894	3313	311

3. Vehicles selected are all from Company A's 3rd platoon for control purposes. If additional information is required, contact either CPT Klady or CW3 Mc Intosh at extension 3139 or 4720.

FOR THE COMMANDER:


CHARLES H. HUFF
CPT, Armor
Adjutant

Port Carson, Co. Ancho 1943

13 September 1977

SUBJECT: Pilot Test of Arctic Oil at Fort Carson

THRU: Commander
2d Brigade
4th Inf Div (M)
Fort Carson, Colorado 80913

TO: Maintenance Division, DIC
ATTN: Mr. Chester Johnson, Bldg 3800
Fort Carson, Colorado 80913

1. Currently seven M60A1 tanks and one $\frac{1}{4}$ ton M75A2 jeep are participating in this program. Since, the last program report dated 10 August none of the components using the test oil have failed, however field training was minimal.
2. During the next sixty days extensive field training is scheduled and should surface component problems if they are going to occur.

FOR THE COMMANDER:

20:

DAVID E. VAUGHAN
CPT, ARBOR
Adjutant

DEPARTMENT OF THE ARMY
HEADQUARTERS, 1ST FACULTY, 7TH ARMO
"BLACKHAWK"
Fort Carson, Colorado 80913

WAKAA

13 November 1977

SUBJECT: Pilot Test of Arctic Oil at Fort Carson

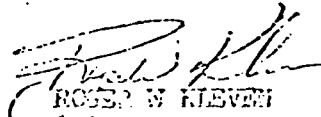
Maintenance Division, DIO
ATTN: Mr Chester Johnson, Bldg 3000
Fort Carson, Colorado 80913

1. During the period 15 September 1977 thru 15 November 1977 this unit conducted extensive down-range training in which the vehicles utilizing the test oil accumulated considerable mileage. None of the components utilizing the test oil have failed, however it was noticed that the components ran at a higher operating temperature than vehicles utilizing regular OE/ADO 50. The operating temperature was not excessive however, and it was noted that the vehicles using the test oil cooled down quicker than vehicles using OE/ADO 50.

2. The following usage data is provided on the test vehicles:

<u>ARMOR #</u>	<u>TYPE</u>	<u>MILES*</u>	<u>HOURS*</u>
HQ-9	M151A2	1323	
HQ-67	M60A1	314	2
HQ-68	M60A1	307	24
B-11	M60A1	347	29
A-31	M60A1	371	41
A-32	M60A1	395	39
A-33	M60A1	653	130
A-34	M60A1	272	45
A-35	M60A1	534	73

* Accumulative between 15 Sep 77 & 15 Nov 77


ROGER W. KIEVEN
CM3, USA
1/77 Project Monitor

DEPARTMENT OF THE ARMY
HEADQUARTERS, 1ST. BATTALION, 77TH. AIRBORNE
"BLACKHAWKS"
Fort Carson, Colorado, 80913

WAM6AA

9 January, 1973

SUBJECT: Pilot Test of Artic Oil at Fort Carson

Maintenance Division, DIO
ATTN: Mr. Chester Johnson, Bldg. 8000
Fort Carson, Colorado, 80913

1. During the period 15 November 77 thru 15 December, 77 this unit did not conduct training which required extensive equipment usage. Test vehicles did not accumulate a great deal of mileage or hours of operation as indicated in paragraph 2, below. Only one vehicle, A-33, consumed any assemblies which might be related to engine operation. Two batteries, 6TN, were replaced on that vehicle. Replacement of the batteries should be interpreted as below normal usage. Vehicles utilizing C3/EO-30 are experiencing a higher failure rate with regard to 6TN batteries.

2. The following usage data is provided on the test vehicles:

<u>Admin.#</u>	<u>Type</u>	<u>Miles</u>	<u>Hours</u>	<u>*Oil Added</u>	<u>Fuel Added</u>
HQ9	M151A2	156		1	17
HQ67	M60A1	27	5	9	51
HQ68	M60A1	3	7	6	76
B11	M60A1	10	2	7	40
A31	M60A1	31	3	8	43
A33	M60A1	12	3	6	45
A35	M60A1	34	3	12	58

* Quarts of oil.

ROGER W. KLEVEN
CMC3, USA
1/77 PROJECT MONITOR

DEPARTMENT OF THE ARMY
HEADQUARTERS, 1ST. BN. 77TH. ARMOR
"BLACKJAWKS"
FORT CARSON, COLORADO 80913

5-APRIL-1973

SUBJECT: Pilot Test of Arctic Oil at Ft. Carson

MAINTENANCE, DIO
ATTN: Mr. Chester Johnson, Bldg. 8000
Ft. Carson, Colorado 80913

1. During the period 16, December 1977 thru 20 March 1978, this unit conducted its annual tank gunnery program which required higher than normal equipment usage. In addition to the tank gunnery program, the wheel vehicles in the battalion convoyed to and from Ft. Irwin, CA. and participated in extensive field training. This accounts for the extensive mileage accumulated on HQ-9, the M151A2 involved in the test program. The only engine oil related maintenance problem encountered was with A-34, Ser# 5924, which developed a leaking seal around the injector pump drive shaft. Subject engine was turned in to DIO, Maintenance on Work Order # D5384. Two power plants, from A-31, Ser# 5747 and A-35, Serial # 2894, were submitted for evaluation under the AOAP. Results of these evaluations and of parts required for powerplant with leaking seal can be obtained from MAJOR ITEM Rebuild section, FC 4228.

2. The following usage data is provided on the test vehicles:

Admin.#	Type	Miles	Hours	Oil Added(qts)	Fuel Added
HQ-9	M151A2	5365		1	287
HQ-67	M60A1	15	1	0	0
HQ-68	M60A1	98	21	4	80
B-11	M60A1	195	18	8	166
A-31	M60A1	142	19	5	129
A-33	M60A1	102	13	0	97
A-34	M60A1	63	10	4	54
A-35	M60A1	112	32	16	172

ROGER W. KLEVEN
CW3, USA
1/77 Project Officer

DEPARTMENT OF THE ARMY
HEADQUARTERS 1ST. BATTALION, 77th. AIRBORNE
"BLACKHAWKS"
FORT CARSON, COLORADO, 80913

9-June, 1978

SUBJECT: Synthetic Oil Test Program

Maintenance Division, DIO
ATTN: Mr. Chester Johnson
Bldg. 8000
Ft Carson, Colorado, 80913

1. During the period 21 March, 1978 thru 20 May, 1978 two of the engines in the synthetic oil test program were replaced. These engines, serial nos. 8860 (A-31) and 3313 (A-35) were replaced on recommendation of the Major Items Rebuild Unit, DIO, Maintenance Division, based on an evaluation which indicated extremely low compression on 3 or more cylinders on each engine. An exact evaluation report can be obtained from the Major Item Rebuild Unit, FC 4228.

2. The following usage data is provided on the test vehicles:

Admin#	Type	Miles	Hours	Oil Added(Qts)	Fuel Added
HQ-9	M151A2	535		0	79
HQ-67	M60A1	47	3	1	50
HQ-68	M60A1	15	3	1	25
B-11	M60A1	94	40	5	350
A-31	M60A1	53	6	10	80
A-33	M60A1	14	2	1	0
A-34	M60A1	8	1	0	0
A-35	M60A1	3	1	8	0

3. Effective 9-June, 1978 the program has been expanded to include the transmissions in all M60A1 vehicles and the final drive assemblies in HQ-67. Additionally, A-32 has been re-inserted into the test program. The following list of serial numbers is provided for control purposes:

Admin#	Type	Veh. Ser. No.	Eng. Ser. No.	Trans. Ser. No.	Final Drive
HQ-9	M151A2	A151-27255	5029116		
HQ-67	M60A1	6983	1074	43942	L,9272, R-2425
HQ-68	M60A1	6947	12080	25687	
B-11	M60A1	5905	3213	43637	
A-31	M60A1	5747	A0654	18333	
A-32	M60A1	6990	10006	35616	
A-33	M60A1	3632	3606	17265	
A-34	M60A1	5924	304	28604	
A-35	M60A1	2894	A0809	29929	

Robert W. Kiewen
ROBERT W. KIEWEN,
C/3 USA
EN. MAINT. TECH.

DEPARTMENT OF THE ARMY
HEADQUARTERS, 1ST. BATTALION, 77TH. ARMOR
"BLACKHAWKS"
Fort Carson, Colorado, 80913

WAM6AA-BMC

5 July 1978

SUBJECT: Synthetic Oil Usage Data

Maintenance Division DIO
ATTN: Mr. Chester Johnson
Bldg. 8000
Ft. Carson, Colorado, 80913

1. During the period 21 May 78 thru 30 June 78, a number of the vehicles in the test program accumulated a significant amount of mileage/hours of operation. This is attributed to the fact that subject vehicles were on loan to the Nebraska National Guard (67th. Ede. BENG)

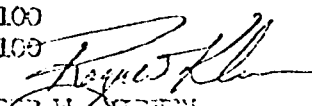
2. Only two significant problem areas were encountered. One vehicle, Admin. # HQ-68, sustained major engine damage during operation. One or two connecting rod bearing caps were thrown through the bottom of the crankcase during operation. The powerplant was work-ordered to DIO Maint. for evaluation and repair on W/O # 7237 on 26 June 1978. Ser. # of replacement engine is 6817.

Two vehicles, HQ-67 & A-32, ruptured transmission oil cooler lines during normal operation reflected by the amount of oil added as shown in para. 3, below.

The second significant problem encountered was a serious overheating of the tanks equipped with AVDS-1790-2A engines. Engines ran in the "Red" zone of the temperature gauge after only 3-5 miles of operation and had to be cooled down before further operation. Tanks with AVDS-1790-2B (Rise) also ran hotter than normal, but not in the "Red" zone.

3. The following usage data is provided on the test vehicles:

Bumper #	Miles	Hours	Eng ^{Oil}	Trans	Fuel
HQ-9	101	0	0	0	29
HQ-67	147	17	11	64	125
HQ-68	167	19	8	0	140
B-11	97	22	0	0	60
A-31	161	16	4	0	135
A-32	173	17	0	64 qts.	135
A-33	142	15	11	0	115
A-34	55	7	6	0	100
A-35	110	14	7	0	100


ROGER W. KIRTVEN,
CWS USA
EN. MAINT. TECH.

DEPARTMENT OF THE ARMY
HEADQUARTERS, 1ST BATTALION, 77TH. AIRBOR
"BLACKHAWKS"
FORT CARSON, COLORADO, 80913

WAN6AA

10-August-1973

SUBJECT: Synthetic Oil Usage Data

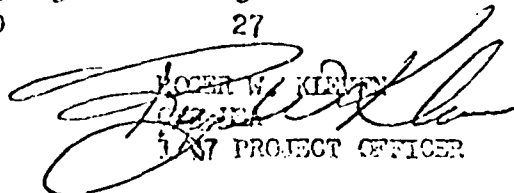
DIO, Maintenance
ATTN: Mr. Chester Johnson
Ft. Carson, CO. 80913

1. During the period 1-July-78 thru 31-July-78, routine training requirements resulted in some vehicles accumulating extensive mileage/usage. A considerable amount of oil was used in maintaining correct levels in the transmissions of two vehicles as indicated below. This can be attributed to broken transmission oil cooler lines which is a somewhat routine malfunction and should not be construed a result of synthetic oil use. A more serious effect of synthetic oil use is the problem of engine overheating. While not as prevalent in vehicles in the program equipped with -2D engines, the vehicles with -2A engines heat up rapidly within 2-3 miles of operation and must be cooled down (transmission in neutral, engine run 1000-1200 RPM's) Frequently, before proceeding.

2. Not reflected in the figures below is approximately 54 gallons of oil "consumed" in oil changes directed by the Oil Analysis Laboratory here at Fort Carson. Also, 16 gallons were used to replace oil inadvertently drained by a new, inexperienced crew during a "Q" service. This crew has since been counseled & briefed on the current program.

3. The following usage data is provided on the test vehicles:

Admin.#	Type	Miles	Hours	Oil Added		Fuel Added
				Eng	Trans	
A-31	M60A1	68	13	0		50
A-32	M60A1	281	44	3	5	270
A-33	M60A1	81	7	8	36	150
A-34	M60A1	6	2	0	0	0
A-35	M60A1	48	5	0	8	80
E-11	M60A1	235	25	12	qts	475
HQ-67	M60A1	137	13	5	30	150
HQ-68	M60A1	13	1	0	0	0
HQ-9	M151A2	371		0		27


ROBERT W. KLINE
1A7 PROJECT OFFICER

DEPARTMENT OF THE ARMY
HEADQUARTERS, 1ST. BATTALION, 77TH. ARMOR
"BLACKHAWKS"
Fort Carson, Colorado, 80913

MAN6AA

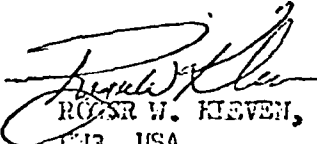
23 August 1978

SUBJECT: Synthetic Oil Usage Data

Maintenance Division, DIO
ATTN: Mr. Johnson
Bldg. 8000
Fort Carson, Colorado, 80913

1. Report covers only 15 day period due to changeover in submission time frames for oil samples as directed by 4th. Inf. Div. DIO REMC and Fort Carson Oil Analysis Lab.
2. No significant problems were encountered during subject time frame as little vehicle activity was scheduled.
3. The following usage data is provided on test vehicles:

<u>Barper #</u>	<u>Miles</u>	<u>Hours</u>	<u>Eng</u>	<u>Trans</u>	<u>Fuel</u>
			<u>Oil</u>		
HQ-9	109	0	0	0	32
HQ-67	3	1	0	0	0
HQ-63	25	3	0	0	15
B-11	8	1	0	0	0
A-31	5	1	0	0	0
A-32	0	0	0	0	0
A-33	37	2	8	0	35
A-34	5	1	3	0	0
A-35	0	0	0	0	0


ROGER W. KIEVEN,
CJ3 USA
BN. MAINT. TECH.

REPORT OF COMBAT UNIT
 1. NAME OF THE UNIT: 1st BATTALION, 7th AVIATION
 2. NAME OF THE COMPANY: 1st COMPANY
 3. NAME OF THE PLATOON: 1st PLATOON

4 October, 1967

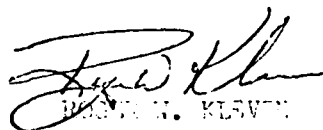
1. Title: Synthetic Oil Usage Data

2. To: Maintenance
 3. From: Mr. Chester Johnson
 4. Station, Co 32215

1. During the period 1 Sep 78 to 30 Sep 78, two engines were replaced due to ACIP results, and one transmission due to internal failure. One engine serial # 3213 (B-11) is not utilizing synthetic oil but is being used as a base line (comparison) for other components in the program. The new serial number for B-11 engine is 3214. The second engine # 304, in tank # A-24, is utilizing synthetic oil. The new serial number for A-34 engine is 3313. The transmission which was replaced was from the same tank (A-24) and the new serial number is 29017. Cause for transmission failure is unknown.

2. The following usage data is provided on test vehicles:

Engine #	Miles	Hrs	Fuel	Eng Oil	Tran Oil
B-66	50	7	80		11g
B-47	40	3	346	13g	
A-67	49	2			
B-9	355			1g	
B-11	93	13			
A-31	93	11	235		
A-32	71	9	200		
A-33	46	15	240	8g	
A-24	0	0	0		
A-35	150	11	115		



ROBERT H. KLEVIN
 CMB, 7A
 Battalion Maintenance Technician

STATEMENT OF WORK
 RE: DEPARTMENT OF THE ARMY, 77th AVIATION
 "BLACKWATER"
 FORT CARSON, COLORADO, 80033

1000

9 November, 1973

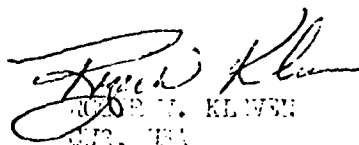
1000 Synthetic Oil Usage Data

Maintenance Division, D10
 ATTN: Mr Chester Johnson
 Ft Carson, Co 80013

1. During the period 1 Oct 73 to 31 Oct 73, test vehicles participated in a mid-cycle gunnery program and a combined arms live fire exercise. Although a significantly higher amount of synthetic oil was used it is attributable to oil changes directed by the installation oil lab. The only exception to this is the two (2) gallons added to the transmission in A-32. This oil was lost to a minor leak. Also, during a quarterly service, it was found that the serial # of the engine in A-32 was incorrectly reported. The correct serial number is 1000.

2. The following usage data is provided, on the test vehicles:

Engine #	Miles	Hours	Fuel	Engine Oil	Trans Oil
66	113	12	150		
67	212	21	475	12	
68	90	11	150		
9	2.00 (10 parts) (not engine #)				
21	11	112	230	15	
22	163	31	205		
32	104	17	150	17	2
33	123	21	215	19	18
34	126	21	225	24	13
35	57	5			


 JOHN M. KLIEN
 SFC, USA

Battalion Maintenance Technician

DEPARTMENT OF THE ARMY
HEADQUARTERS, 1ST BATTALION, 77TH ARMOR
"BLACKWATERS"
FORT CARSON, COLORADO 80913

WANGAA-BFO

4 January 1979

SUBJECT: Synthetic Oil Usage Data

DEO, Maintenance Division
ATTN: MR Chester Johnson
Ft Carson, Co 80913

1. During the period 1-30 November 1978, 4 of the 5 tanks in A Company required oil changes as directed by the Fort Carson Oil Analysis Lab. Very little usage data was accumulated during the above cited period because of a lack of downrange training commitments.

2. The following usage data is provided on the test vehicles:

Bumper Number	Miles	Hours	Fuel	Eng Oil	Tran Oil	Final Dr.
HQ 9	244	N/A	17	5 g		
HQ 67	13	7				2.5 g
HQ 68	94	18	150			
B 11	0	0				
A 31	4	1				
A 32	0	0		(Ch) 13g	(Ch) 17g	
A 33	0	0		(Ch) 13g	(Ch) 17g	
A 34	2	1		(Ch) 13g	(Ch) 17g	
A 35	9	1		(Ch) 13g	(Ch) 17g	

ROGER W. KLEVEN
CW3, USA
Battalion Maintenance Technician

DEPARTMENT OF THE ARMY
1ST BATTALION, 77TH ARMOR
"BLACKHAWKS"
FORT CARSON, CO 80913

WAN6AA

25 January, 1979

SUBJECT: Synthetic Oil Usage Data

DIO, Maintenance Division
ATTN: Mr Chester Johnson
Ft Carson, Co 80913

1. Extensive use of subject vehicles did not occur during the period 1-31: January, 1978. An insignificant amount of time did accumulate on the vehicles due to the cold weather and the requirement to run the vehicles in place to keep the batteries charged.

2. The following usage data is provided on test vehicles:

Bumper No	Fuel	Hours	Miles	Eng Oil	Trans Oil	F.D. Oil
HQ 9	4		69	0		
HQ 67	125	7	8	0	0	0
HQ 68	75	5	13	2 gal	0	
B 11	60	5	27	0	0	
A 31	40	3	0	0	0	
A 32	55	19	18	0	0	
A 33	0	0	0	0	0	
A 34	80	4	2	0	0	
A 35	150	6	64	0	0	

ROGER W. KLEVEN
CW3, USA
Battalion Maintenance Technician

DEPARTMENT OF THE ARMY
HEADQUARTERS, 1ST BATTALION, 77TH ARMOR
"BLACKHAWKS"
FORT CARSON, COLORADO 80913

WAN6AA-BMO

1 February, 1979

D10, Maintenance Division
ATTN: Mr Chester Johnson
Fort Carson, Co 80913

1. The only significant usage of synthetic oil during the period 1-31 January, 79 occurred in the third platoon tanks of A Co 1-77. A 31 ruptured a transmission oil cooler line and lost 5 gallons of oil before the vehicle could be shut down. The engine oil on A 32 was changed on the direction of the Ft Carson Oil Analysis Lab. A 35 developed a leak at the oil filter housing.

2. The following usage data is provided on the test vehicles:

Bumper No	Fuel	Hours	Miles	Eng Oil	Trans Oil	F.D. Oil
HQ 9	8		133	0		
HQ 67	0	1	0	0	0	0
HQ 68	25	1	0	1 gal	0	
B 11	0	1	8	0	0	
A 31	125	12	37	2 gal	5 gal	
A 32	335	17	18	17 (ch)	0	
A 33	0	0	0	0	0	
A 34	0	2	0	0	0	
A 35	0	2	34	4 gal	0	

ROGER W. KLEVEN
CW3, USA
Battalion Maintenance Technician

DEPARTMENT OF THE ARMY
HEADQUARTERS, 1ST BATTALION, 77TH ARMOR
"BLACKHILLS"
Fort Carson, Colorado 80913

MAN6A1-EMO

2 March 1979

SUBJECT: Synthetic Oil Usage Data

DIO, Maintenance
ATTN: Chester Johnson
Fort Carson, Co 80913

1. The below listed data covers the period 1-28 Feb 79. The increase in usage data is due to Annual Tank Gunnery conducted during this period. As shown, two of the test vehicles are in Minimum Equipment Level Training Storage. These vehicles did not accumulate any usage data.

2. The following usage data is provided on test vehicles:

Unit #	Miles	Hours	Eng Oil	Trans Oil	Fuel
A 31	69	16	8	0	110
A 32	73	19	3	12	90
A 33	76	18	4	0	120
A 34	(MELT)				
A 35	57	17	2	14	95
B 11	764	25	9	26	400
HQ 67	(MELT)				
HQ 68	31	11	0	0	70
HQ 9	469		5 (ch)		47

ROGER W. KLEVEN
CW3, USA
Battalion Maintenance Technician

DEPARTMENT OF THE ARMY
HEADQUARTERS, 1ST BATTALION, 77TH ARMOR
"DIABOLICAL"
Fort Carson, Colorado 80913

WAC61A-880

6 April 1979

SUBJECT: Synthetic Oil Usage Data

DIO, Maintenance
ATTN: Chester Johnson
Fort Carson, Co 80913

1. During the period 1-31 Mar 79 increased vehicle usage due to tactical training resulted in higher oil consumption and a number of complete oil changes as directed by the Post Oil Lab.

2. The following usage data is provided on test vehicles:

Unit #	Fuel	Miles	Hours	Eng Oil	Trans Oil
A 31	300	0	0	40	45
A 32	420	152	70	83	28
A 33	600	141	22	13	30
A 34	(HELT)				
A 35	580	256	31	84	20
HQ 37	(HELT)				
HQ 68	160	48	3	0	0
HQ 9	55	669	0	0	
B 11	550	121	18	8	0

ROGER W. KIEVEN
CW3, USA
Battalion Maintenance Technician

DEPARTMENT OF THE ARMY
HEADQUARTERS, 1ST BATTALION, 77TH ARMOR
"BLACKHAWKS"
Fort Carson, Colorado 80913

WAN6AA-BMO

2 May 1979

SUBJECT: Synthetic Oil Usage Data

DIO, Maintenance
ATTN: Mr Chester Johnson
Fort Carson, Co 80913

1. During the period 1-30 April, the tanks of third platoon, A Company did accumulate a considerable number of hours of operation. Mileage was relatively low in that they were committed to searchlight detail for 2-3d Armcr's Annual Tank Gunnery, a detail that requires extensive main engine operation but not much movement.
2. Also this period, the engine on A-32 was replaced due to a leaking lower oil seal on one of the engine's cooling fans. Old engine serial number was 10004. The new engine serial number is A0005 (RISE).
3. The following usage data is submitted for the period 1-30 April 1979:

Admin#	Fuel	Miles	Hours	Eng Oil	Trans Oil	F.D. Oil
HQ 68	0	0	0	0	0	N/A
HQ 9	46	543		2 qt		
B 21	190	60	41	4 qt	2 qt	
A 31	160	52	37		16 ch	
A 32	110	77	3	4 qt		
A 33	75	12	2		16 ch	
A 35	225	68	67	8 qt	4 qt	

ROGER W. KLEVEN
CW3, USA
Project Monitor

DEPARTMENT OF THE ARMY
HEADQUARTERS, 1ST BATTALION, 77TH ARMOR
"BLACKHAWKS"
Fort Carson, Colorado 80913

WAN6AA-BMO

4 June 1979

SUBJECT: Synthetic Oil Usage Data

DIO, Maintenance
ATTN: Mr Chester Johnson
Fort Carson, Co 80913

1. Two significant maintenance problems occurred during the month of May on tanks utilizing synthetic oil. The engine in A-35 (Serial # A0808) threw a rod through the side of the block during downrange maneuvering. The engine is still on hand in this unit and has not been replaced due to lack of a replacement assembly. Incident occurred on 2 May 79. The second significant problem occurred on a M60A1 tank which is in MELT (Minimum Equipment Level Training) storage. Information received by this unit from the MELT personnel indicates replacement of the transmission on A-34 is necessary. Exact nature of the malfunction is unknown. Further information may be gained by contacting MAJ Mollard, MELT 877-4774. Incident occurred on 4 May 79.

2. The following usage data is provided for the period 1-31 May 1979:

Unit #	Fuel	Miles	Hours	Eng Oil	Trans Oil
B 11	400	158	22		
A 31	0	0	0		
A 32	403	74	9	20 ch	20 ch
A 33	130	56	6		
A 35	0	30	32	8 qt	3 qt
HQ 63	770	208	34		
HQ 9	127	1116			

ROGER W. KLEVEN
CW3, USA
Project Monitor

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Page 5